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SMPTE RECOMMENDED PRACTICE

Cross-Modulation Tests for Variable-Area Photographic Audio Tracks



Page 1 of 6 pages

1 Scope and purpose

1.1 This practice describes the cross-modulation method of measuring high-frequency distortion introduced during the production of variable-area audio motion-picture release prints. Through measurements of distortion at various negative densities, it is possible to choose negative densities that will produce audio prints having minimum distortion and optimum quality under the particular method of processing employed.

1.2 Cross-modulation tests are used extensively in establishing and maintaining photographic control of variable-area audio tracks. In consideration of waveform, output level, and noise reduction, it is necessary for variable-area prints to have high density contrast. At satisfactorily high track densities, an appreciable amount of image spread occurs, producing partial rectification of high frequencies. To compensate for this, an equal and opposite amount of image spread is introduced into the negative. Therefore, to establish the correct negative- and print-density combination, amplitude-modulated high frequencies are recorded and printed over a suitable density range. By measuring the rectified component from the prints, the correct density combinations are indicated.

2 Test method

2.1 The test track described in clause 3 is recorded and developed under standard conditions for the process being checked. A series of recordings is made at different lamp currents to give a range of negative densities above and below the expected optimum density. A print is then made of the negative series under standard conditions of exposing and printing for the print film under test. There should be sufficient unspliced film ahead of the test track to permit stabilization of printer speed. Alternatively, a single negative can be made and a series of prints made from that negative. A third and more comprehensive test method involves exposing a negative series and printing it at a series of print densities.

The distortion content of the test track print is then measured. In making the measurements, the test track print is threaded through the audio head of the film reproducing device in the proper manner according to the position of the audio track. The distortion of each section of the print is then measured using one of the methods described in 4.1.5.

The negative density that results in the least amount of distortion in the print is considered the optimum negative density for the set of conditions used.

2.2 Since the method described here measures the overall distortion for a process involving numerous variables, each of which may affect the total distortion, it is necessary that all such variables (except the negative density, which is purposely varied to find the optimum) in the recording and processing of the test track be maintained at the same values as they are normally in the process to be checked. The variables include film stock (both audio negative and print), printer exposure, negative and print gamma, color temperature of printer light, and type of printer.

3 Test track

3.1 The test track consists of three sections recorded in sequence at the same negative recorder lamp-current setting.

3.1.1 Section 1: 400 Hz $\pm$ 10 Hz constant amplitude sinusoidal signal at $(80 \pm 5)\%$ of full modulation (or 2.0 dB $\pm$ 0.5 dB below full modulation).

3.1.2 Section 2: A high-frequency sinusoidal signal amplitude modulated to $(80 \pm 5)\%$ of full modulation (2.0 dB $\pm$ 0.5 dB below full modulation) at 400 Hz $\pm$ 10 Hz. The peak amplitude of this modulated signal will be $(80 \pm 5)\%$ of that required for full modulation of the audio track (or 2.0 dB $\pm$ 0.5 dB below full modulation). The high frequency will be 6000, 8000, or 9000 Hz $\pm$ 100 Hz for 35 mm, and 6000 Hz $\pm$ 100 Hz for 16 mm.

3.1.3 Section 3: Track fully modulated at 30 Hz or less, or forward and reverse bias applied with no modulation present, suitable for density measurement of both clear and opaque areas.

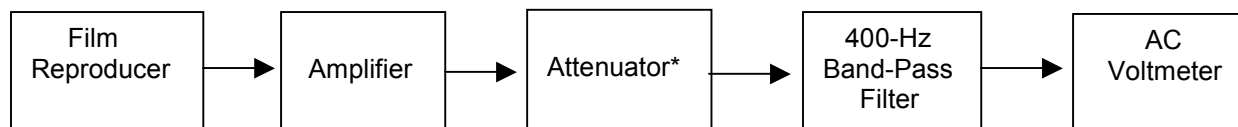
3.2 Sections 1 and 2 should have a running time of 10 seconds, and section 3 at least 1 second. Neither the 400-Hz nor the high-frequency modulated signal shall contain more than 5% total harmonic distortion. The modulated wave of section 2 shall not contain a 400-Hz component greater than 50 dB below a 400-Hz signal with the same peak-to-peak amplitude. The recorder should be adjusted correctly for slit azimuth, track location, and focus.

4 Reproducing and measurement methods

4.1 400-Hz filter method

4.1.1 Reproducing equipment

The reproducing equipment should consist of an audio film reproducer, an amplifier, an attenuator, a 400-Hz band-pass filter, and an AC voltmeter. A typical equipment arrangement is shown in figure 1. The attenuator is optional in some measuring system setups (see annex A.1).



*See 4.1.1

Figure 1 – Reproducing equipment

4.1.2 Signal-to-noise ratio

The signal-to-noise ratio of the entire system shall be at least 55 dB.

4.1.3 Filter

The 400-Hz band-pass filter should have uniform transmission $\pm$ 0.5 dB from 370 Hz to 430 Hz. The filter shall have an attenuation at 4000 Hz of at least 45 dB greater than passband attenuation and an attenuation at frequencies of 6000 Hz and above of at least 55 dB greater than passband attenuation. No specification of attenuation within the passband is required other than the condition of uniform transmission.